BOMBARDIER
Toronto (de Havilland)
PROPRIETARY INFORMATION

PPS 12.06

PRODUCTION PROCESS STANDARD

Installation of Self-Aligning Bearings by Roller or Press Swaging

Issue 11
- This standard supersedes PPS 12.06, Issue 10.
- Vertical lines in the left hand margin indicate technical changes over the previous issue.
- Direct PPS 12.06 related questions to michael.wright@aero.bombardier.com.
- This PPS is effective as of the distribution date.

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1 Scope

1.1 This Production Process Standard (PPS) specifies the procedure and requirements for the installation of grooved race, self aligning bearings by press and roller swaging.

1.1.1 This PPS complements the engineering drawings that specify its use as an authorized instruction. The procedure specified in this PPS must be followed to ensure compliance with all applicable specifications. In general, if this PPS conflicts with the engineering drawing, follow the engineering drawing. The requirements specified in this PPS are necessary to fulfil the engineering design and reliability objectives.

1.1.2 Refer to PPS 13.26 for the subcontractor provisions applicable to this PPS.

1.1.3 Procedure or requirements specified in a Bombardier BAPS, MPS, LES or P. Spec. **do not** supersede the procedure or requirements specified in this PPS.

2 Hazardous Materials

2.1 Before receipt at Bombardier Toronto (de Havilland), all materials must be approved and assigned Material Safety Data Sheet (MSDS) numbers by the Bombardier Toronto (de Havilland) Environment, Health and Safety Department. Refer to the manufacturer's MSDS for specific safety data on any of the materials specified in this PPS. If the MSDS is not available, contact the Bombardier Toronto (de Havilland) Environment, Health and Safety Department.

3 References

3.1 Bombardier Toronto (de Havilland) Specifications

3.1.1 PPS 13.26 - General Subcontractor Provisions.

3.1.2 PPS 31.17 - Solvent Usage.

4 Materials and Equipment

4.1 Materials

4.1.1 Self-aligning bearings as specified on the engineering drawing. Refer to Figure 1 for a breakdown of MS style bearing part numbers.

4.2 Equipment

4.2.1 Insertion, swaging and proof loading tools as specified herein. Alternate tools may be used provided that the bearing is not damaged during installation and the insertion tool does not touch the inner ball of the bearing (e.g., Bombardier Drawing #GT 995139-( ) press swage tool, Bombardier Drawing #GT 996521-( ) roll swage tool or Bombardier Drawing #GT 995748-( ) proof load tool).

4.2.2 Hydraulic press of sufficient capacity to press swage bearings and proof load swaged bearings.

4.2.3 Dalo markers, yellow, Marktex Corp part number MRYEP-DALOYE2, MRYEP-DALOYE3, or MRYEP-DALOYE4.

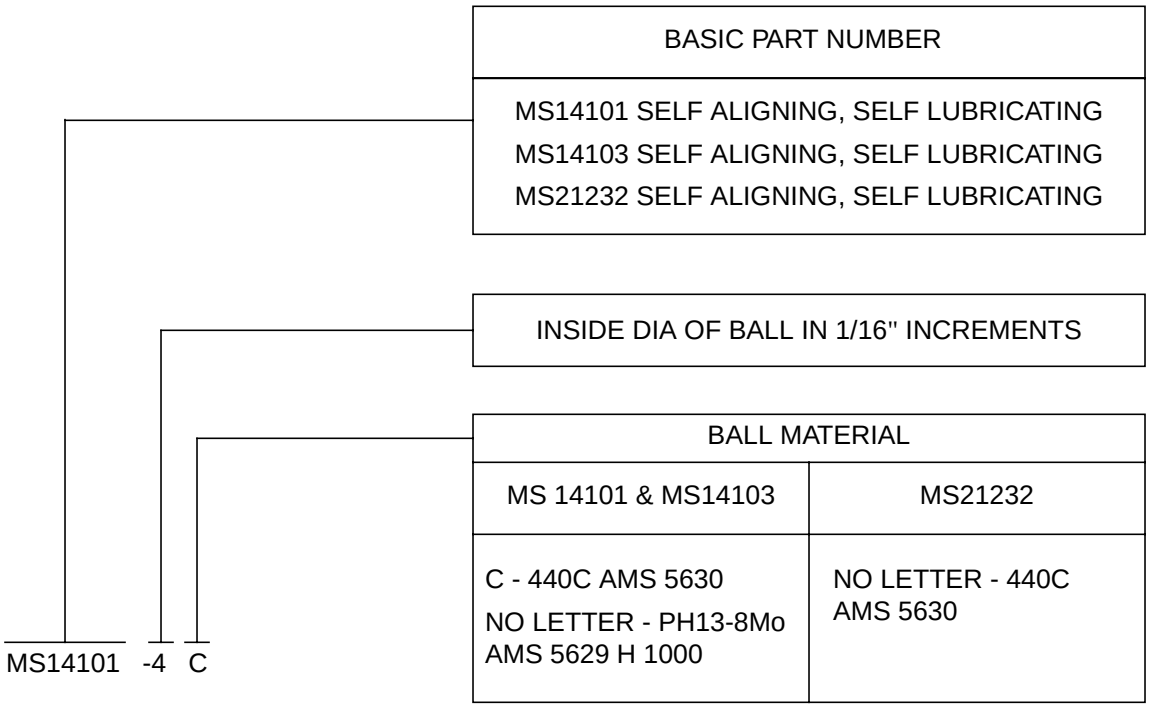


Figure 1 - Part Number Breakdown for MS Bearings

5 Procedure

5.1 General

5.1.1 Press swaging of bearings according to this standard consists of flaring grooved lips on the bearing race outwards onto machined chamfers on the part housing to mechanically retain the bearing in the housing.

5.2 Preparation of Parts

5.2.1 Prepare the parts for bearing installation (e.g., anodize, alodine, etc.) according to the engineering drawing.

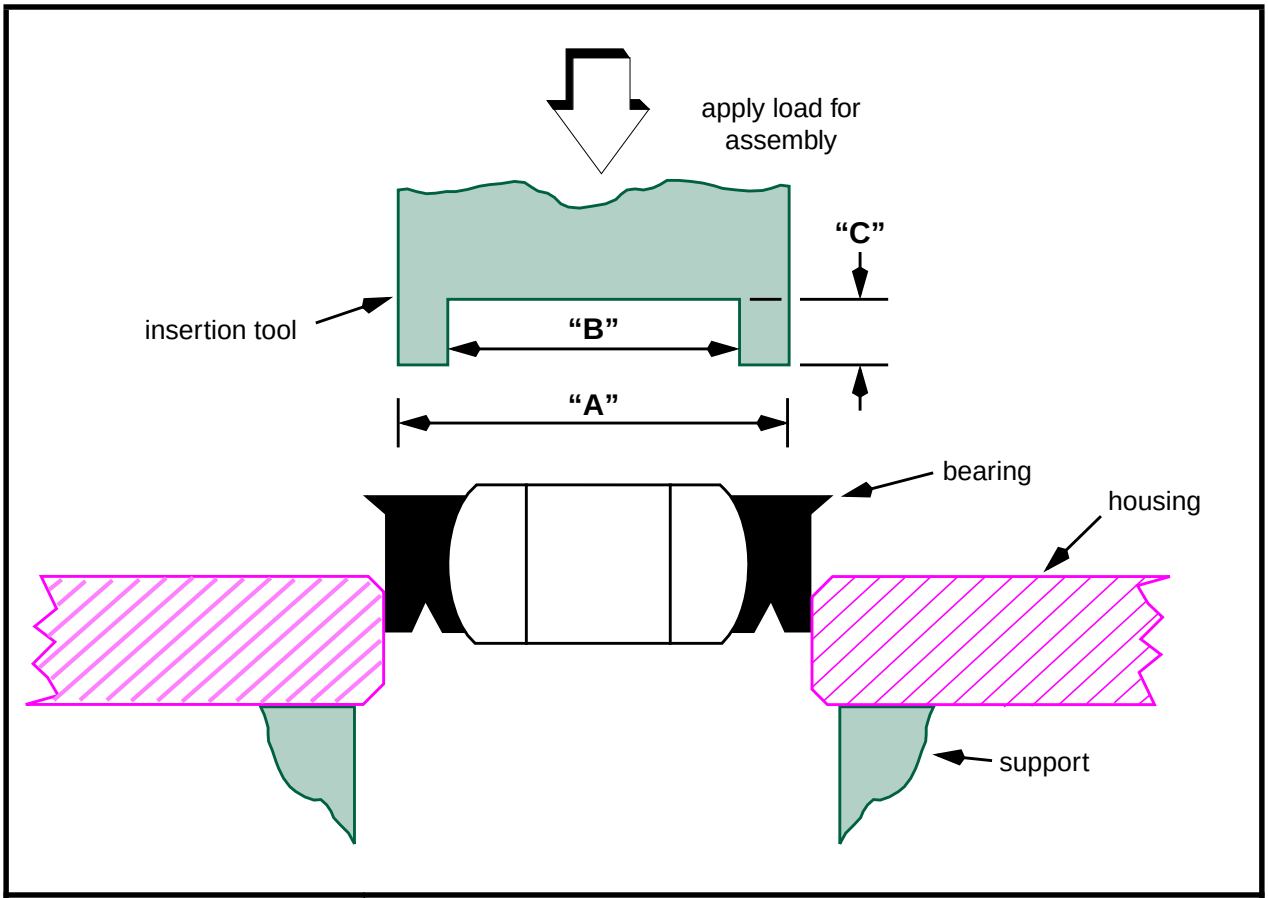
5.2.2 Immediately before installing the bearings, solvent clean the housing bore according to PPS 31.17.

5.2.3 Do not remove bearings from their protective wrapping until immediately before installation.

5.3 Installation of Bearings

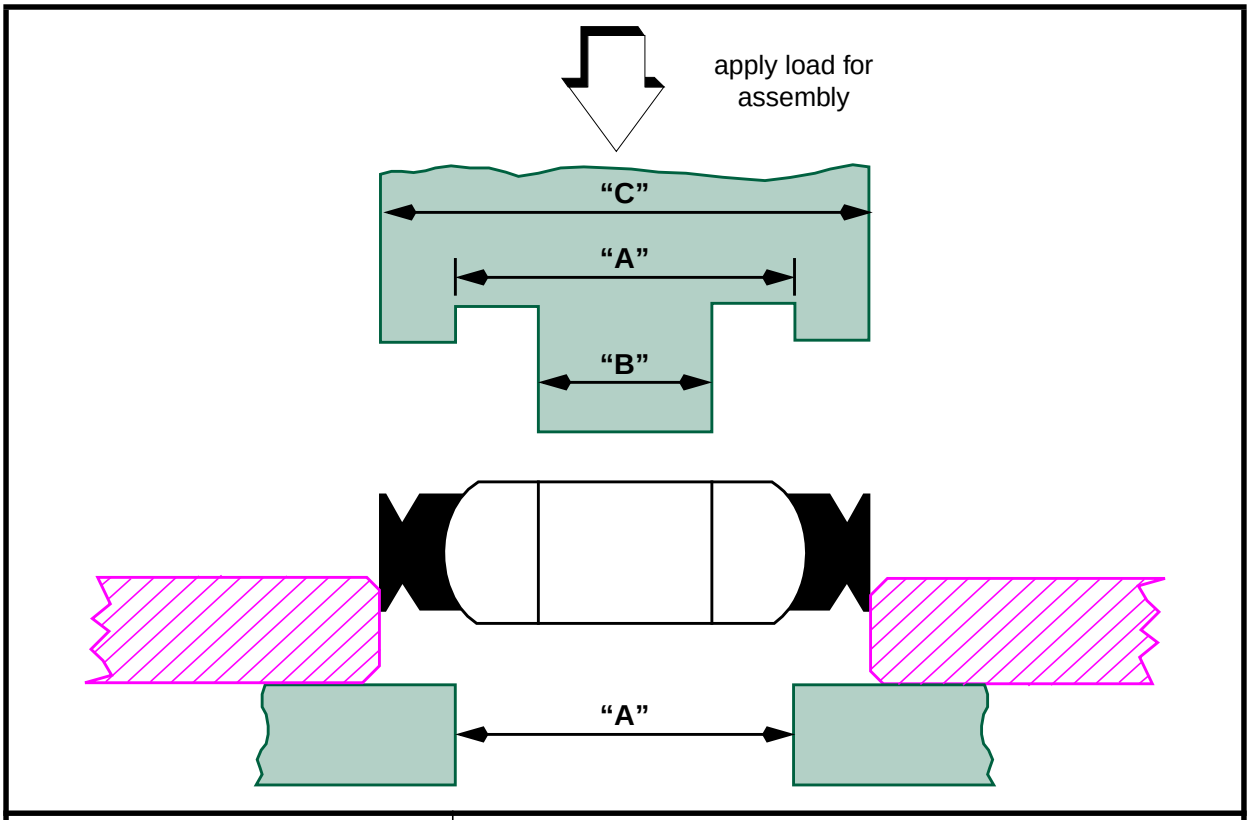
5.3.1 Select the appropriate insertion tools for the bearing from either Table 1 (PSI bearings) or Table 2 (MSbearings).

Table 1 - PSI Bearing Insertion Tool



BEARING	INSERTION TOOL DIMENSIONS		
	"A"	"B"	"C"
P2A1560	1.874" - 1.880"	1.745" - 1.750"	0.187" - 0.200"

Table 2 - .MS Bearing Insertion Tool



BEARING		INSERTION TOOL DIMENSIONS		
		"A"	"B"	"C"
MS14101 & MS21232	-4	0.449" - 0.454"	0.248" - 0.249"	0.649" - 0.654"
	-5 & -5A	0.503" - 0.508"	0.310" - 0.311"	0.743" - 0.748"
	-7	0.612" - 0.617"	0.435" - 0.436"	0.899" - 0.904"
	-8	0.693" - 0.698"	0.498" - 0.499"	0.993" - 0.998"
	-9	0.774" - 0.779"	0.560" - 0.561"	1.086" - 1.091"
	-14	1.127" - 1.132"	0.873" - 0.874"	1.555" - 1.560"
MS14103	-4	0.433" - 0.438"	0.248" - 0.249"	0.618" - 0.623"
	-5	0.485" - 0.490"	0.310" - 0.311"	0.680" - 0.685"
	-6	0.562" - 0.567"	0.373" - 0.374"	0.805" - 0.810"
	-7	0.656" - 0.661"	0.435" - 0.436"	0.930" - 0.935"
	-7A			0.899" - 0.904"
	-8	0.727" - 0.732"	0.498" - 0.499"	0.993" - 0.998"
	-9	0.856" - 0.861"	0.560" - 0.561"	1.118" - 1.123"
	-10	0.915" - 0.920"	0.623" - 0.624"	1.180" - 1.185"
	-14	1.106" - 1.111"	0.873" - 0.874"	1.618" - 1.623"

5.3.2 Install bearings as follows:

Step 1. Install the bearing insertion tools into a suitable arbor press.

Step 2. Support the part housing around the edge of the housing bore on the lower housing support as shown in Figure 2.

Step 3. Align the bearing so that it is even with the bore and carefully press the bearing into the housing. Do not damage the bearing or bearing housing during installation (e.g., by over-pressing or tool misalignment). Ensure that the insertion tool does not touch the inner ball of the bearing.

Step 4. Ensure that both sides of the bearing race are no more than 0.005" below flush to no more than 0.010" above flush with the housing as shown in Figure 2.

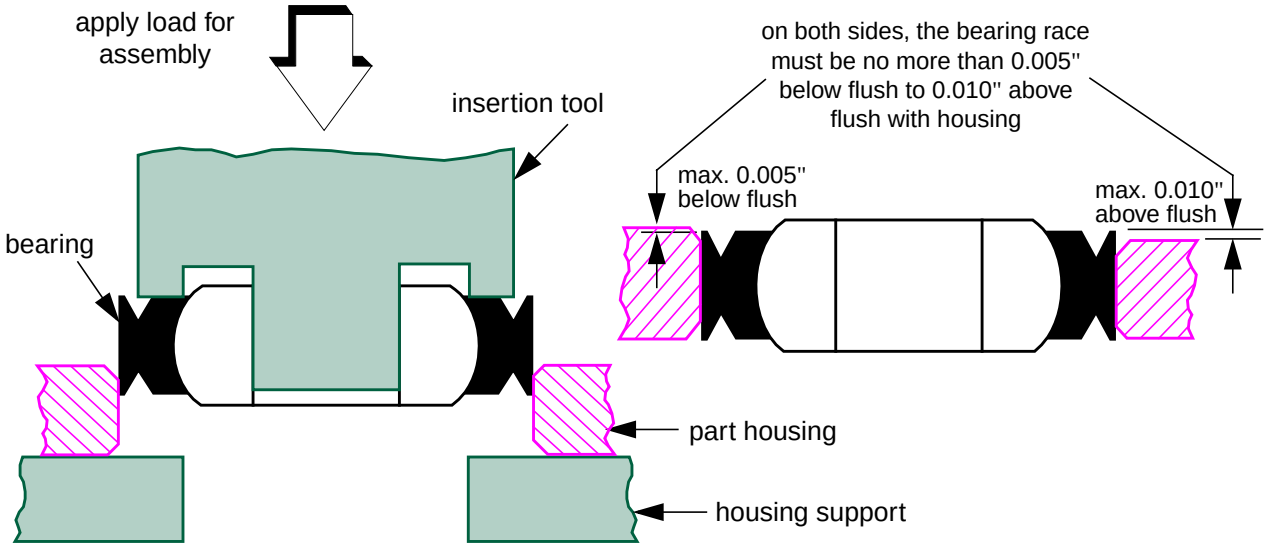


Figure 2 - Installation of MS Type Bearings

5.4 Swaging of Bearings

5.4.1 General

5.4.1.1 MS type bearings can be press swaged as specified in section 5.4.2 or roller swaged as specified in section 5.4.3. Roller swage PSI bearings as specified in section 5.4.3.

5.4.2 Press Swaging of MS Type Bearings

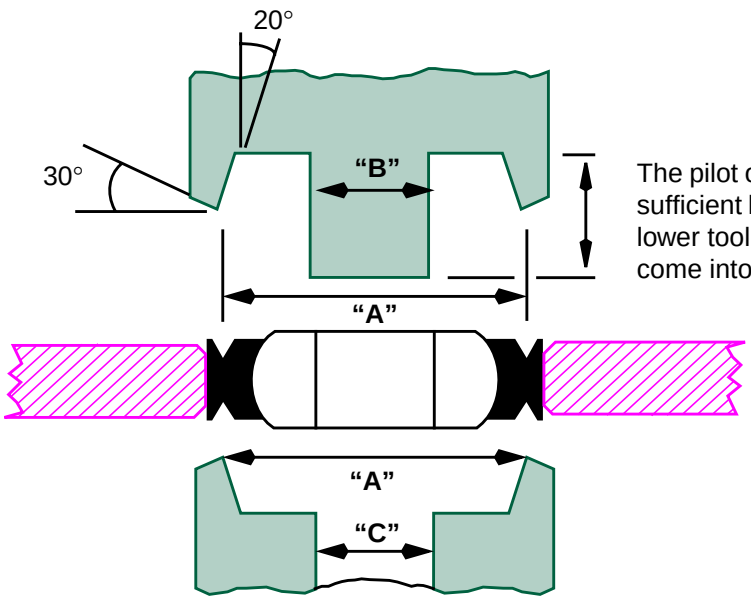
5.4.2.1 Press swage MS type bearings as follows (see Figure 3):

Step 1. Select the appropriate swaging tools for the bearing from Table 3. Visually examine the installation tools for damage or foreign matter that may cause poor installation of the bearing.Install the swaging tools in a suitable hydraulic press (see Equipment section, paragraph 4.2.2).

Step 2. Position the part/bearing assembly in the swaging tool.

Step 3. Holding the part squarely on the anvil, apply the load specified in Table 4 to swage the bearing. Take care to avoid damaging the bearing or bearing housing by over-pressing or improperly aligning the tools.

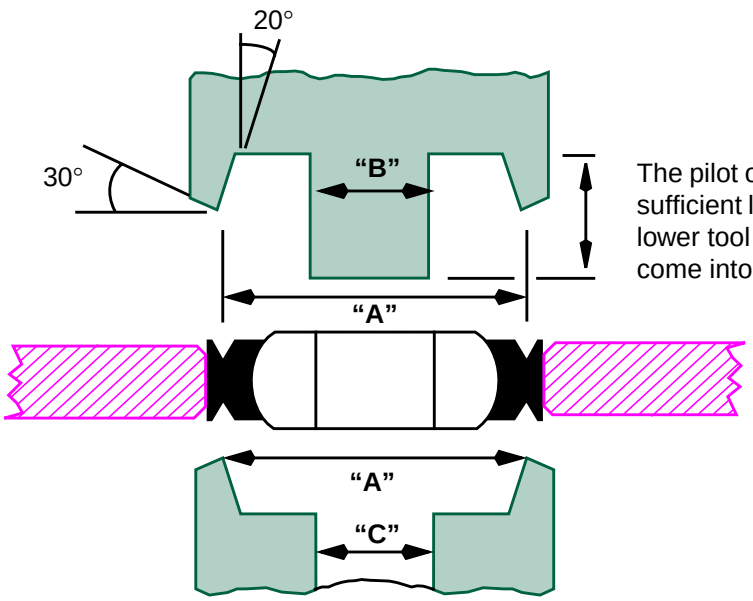
Table 3 - MS Bearing Press Swaging Tool



The pilot of the upper swaging tool must be of sufficient length to engage the pilot hole of the lower tool by 1/4" before the swaging points come into contact with the bearing race.

BEARING		SWAGING TOOL DIMENSIONS		
		"A"	"B"	"C"
MS14101	-4	0.595" - 0.597"	0.248" - 0.249"	0.250" - 0.251"
	-5	0.651" - 0.653"	0.310" - 0.311"	0.313" - 0.314"
	-5A	0.661" - 0.663"	0.310" - 0.311"	0.313" - 0.314"
	-7	0.807" - 0.809"	0.435" - 0.436"	0.438" - 0.439"
	-8	0.877" - 0.879"	0.498" - 0.499"	0.500" - 0.501"
	-9	0.971" - 0.973"	0.560" - 0.561"	0.563" - 0.564"
	-14	1.439" - 1.441"	0.873" - 0.874"	0.875" - 0.876"

Table 3 - MS Bearing Press Swaging Tool



The pilot of the upper swaging tool must be of sufficient length to engage the pilot hole of the lower tool by 1/4" before the swaging points come into contact with the bearing race.

BEARING		SWAGING TOOL DIMENSIONS		
		"A"	"B"	"C"
MS14103	-4	0.564" - 0.566"	0.248" - 0.249"	0.250" - 0.251"
	-5	0.626" - 0.628"	0.310" - 0.311"	0.313" - 0.314"
	-6	0.713" - 0.715"	0.373" - 0.374"	0.375" - 0.376"
	-7	0.838" - 0.840"	0.435" - 0.436"	0.438" - 0.439"
	-7A	0.807" - 0.809"	0.435" - 0.436"	0.438" - 0.439"
	-8	0.901" - 0.903"	0.498" - 0.499"	0.500" - 0.501"
	-9	1.026" - 1.028"	0.560" - 0.561"	0.563" - 0.564"
	-10	1.088" - 1.090"	0.623" - 0.624"	0.625" - 0.626"
	-14	1.502" - 1.504"	0.873" - 0.874"	0.875" - 0.876"
MS21232	-4	0.572" - 0.574"	0.248" - 0.249"	0.250" - 0.251"
	-5	0.636" - 0.638"	0.310" - 0.311"	0.313" - 0.314"
	-7	0.792" - 0.794"	0.435" - 0.436"	0.438" - 0.439"
	-8	0.861" - 0.863"	0.498" - 0.499"	0.500" - 0.501"
	-9	0.955" - 0.957"	0.560" - 0.561"	0.563" - 0.564"
	-14	1.424" - 1.426"	0.873" - 0.874"	0.875" - 0.876"

Table 4 - Swaging Loads for Press Swaging

BEARING		SWAGING LOAD
MS14101 & MS21232	-4	13,500 - 14,850 lbs
	-5 & -5A	15,300 - 16,830 lbs
	-7	19,300 - 21,230 lbs
	-8	25,000 - 27,500 lbs
	-9	29,200 - 32,120 lbs
	-14	40,700 - 44,770 lbs

BEARING		SWAGING LOAD
MS14103	-4	12,900 - 14,190 lbs
	-5	14,100 - 15,510 lbs
	-6	17,900 - 18,799 lbs
	-7 & 7A	20,000 - 22,000 lbs
	-8	25,000 - 27,500 lbs
	-9	26,700 - 29,370 lbs
	-10	28,500 - 31,350 lbs
	-14	42,400 - 46,640 lbs

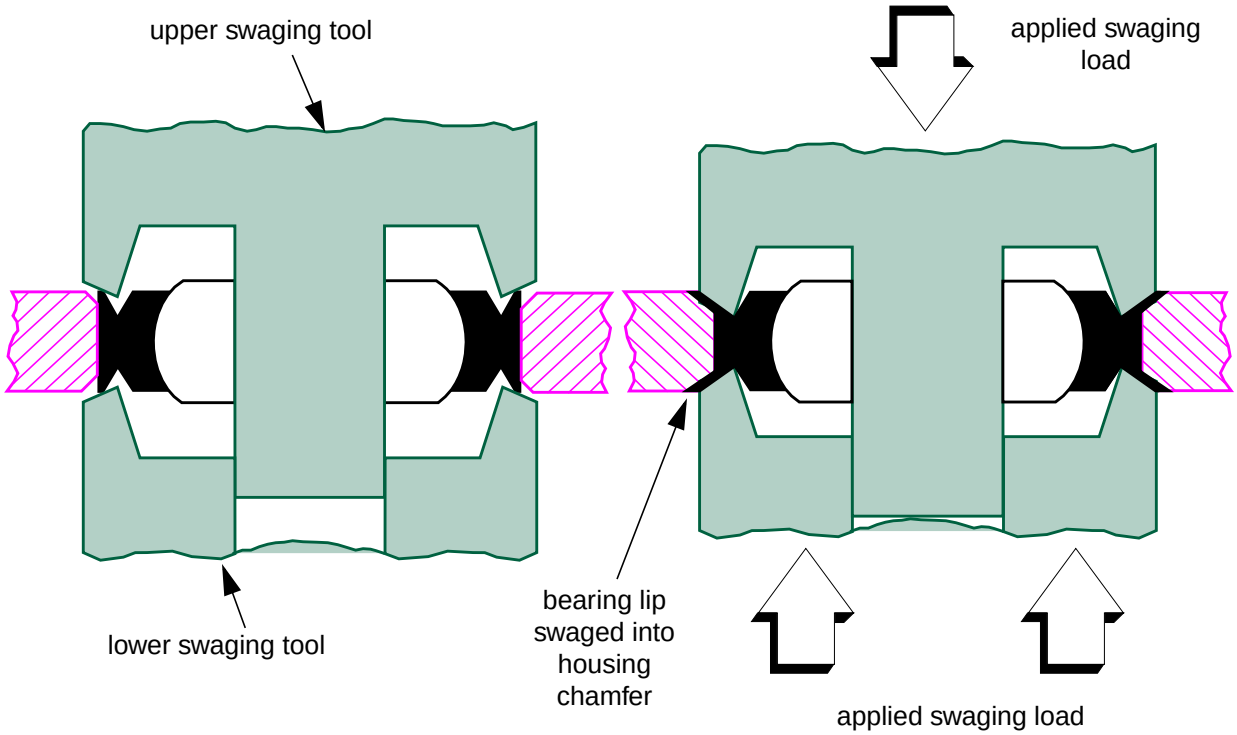


Figure 3 - Press Swaging of MS Type Bearings

5.4.3 Roller Swaging of Bearings

5.4.3.1 For MS bearings, use the swaging tools listed in Table 5. For PSI bearings, use the swaging tool specified in Table 6.

5.4.3.2 Roller swage bearings as follows:

Step 1. Visually examine the installation tools for damage or foreign matter that may cause poor installation of the bearing.

Step 2. Install the swaging tools in a suitable drill press.

Step 3. Position the part/bearing assembly on the swaging tool support.

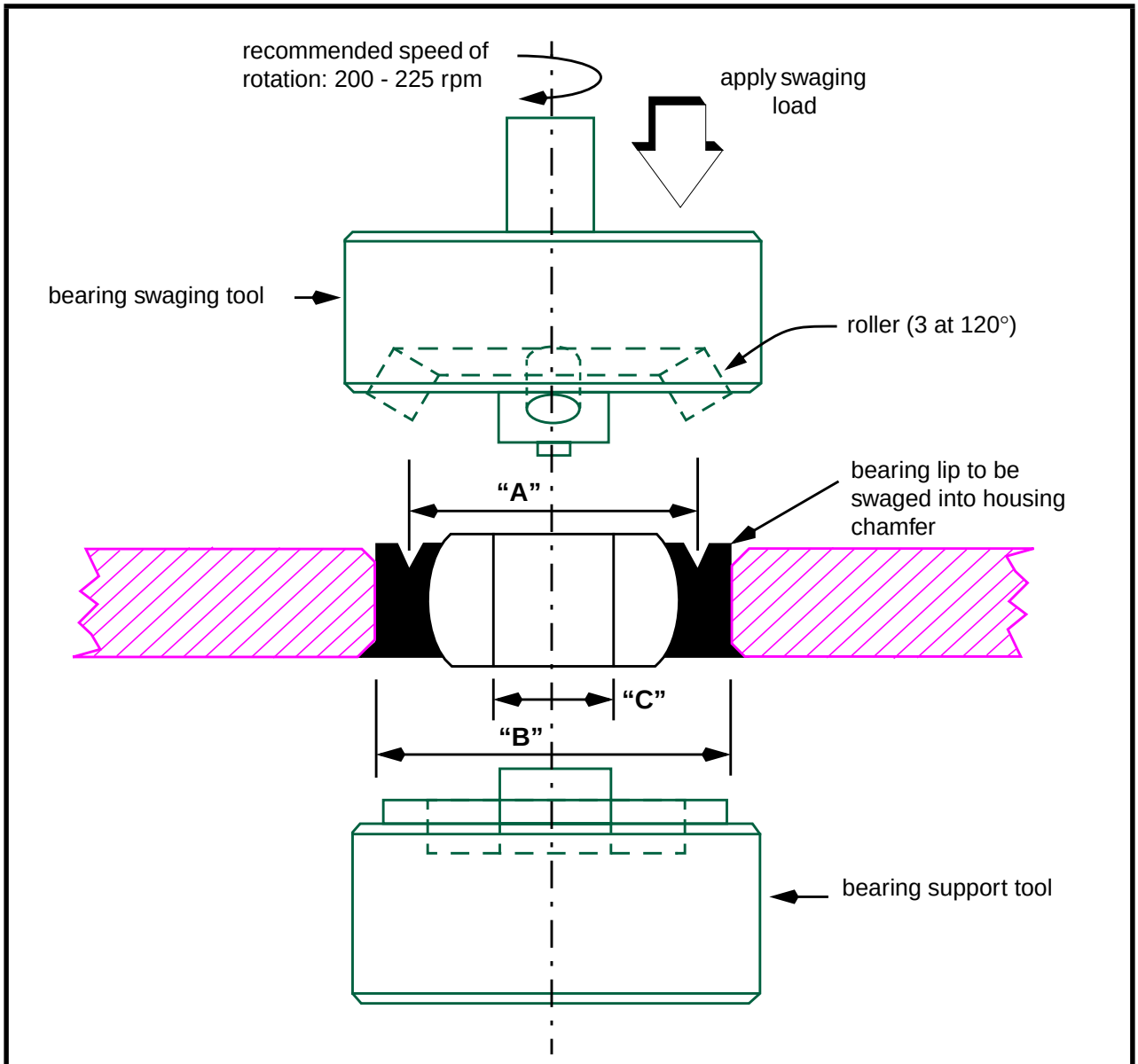
Step 4. Apply a light machine oil onto the roller surfaces.

Step 5. Holding the part squarely on the support tool, begin rotating the upper swage tool and bring it into contact with the bearing. Gradually apply pressure until the edge gap meets the requirements specified in Figure 5. When roller swaging bearings, take care to avoid damaging the bearing or bearing housing by over-pressing or improperly aligning the tools.

Table 5 - Roller Swaging Tools for MS Bearings

BEARING		SHAFER ROLLER SWAGING TOOL
MS14101 & MS21232	-4	RST1003
	-5	RST1005
	-7	RST1007
	-8	RST1009
	-9	RST1011
	-14	RST1017
MS14103	-4	RST1002
	-5	RST1004
	-6	RST1006
	-7A	RST1007
	-7	RST1008
	-8	RST1010
	-9	RST1012
	-10	RST1014
	-14	RST1018

Table 6 - PSI Bearing Roller Swaging Tool



PSI BEARING	BEARING DIMENSIONS		
	"A"	"B"	"C"
P2A1560	1.874" - 1.880"	1.9995" - 2.0000"	1.2495" - 1.2500"

Note 1. The pilot diameter of the upper swaging tool must be of sufficient length to engage the bore of the bearing before coming into contact with the proof points of the bearing race.

5.5 Removal of Swaged Bearings

5.5.1 If necessary, remove installed bearings as follows:

Step 1. Cut through the swaged lip on one side of the bearing race using a piloted fly cutter in a drill press as shown in Figure 4. Take care to avoid cutting into the part housing.

Step 2. Support the part around the edge of the housing bore and press the bearing out of the bore. Take care to avoid deforming the part during removal of the bearing.

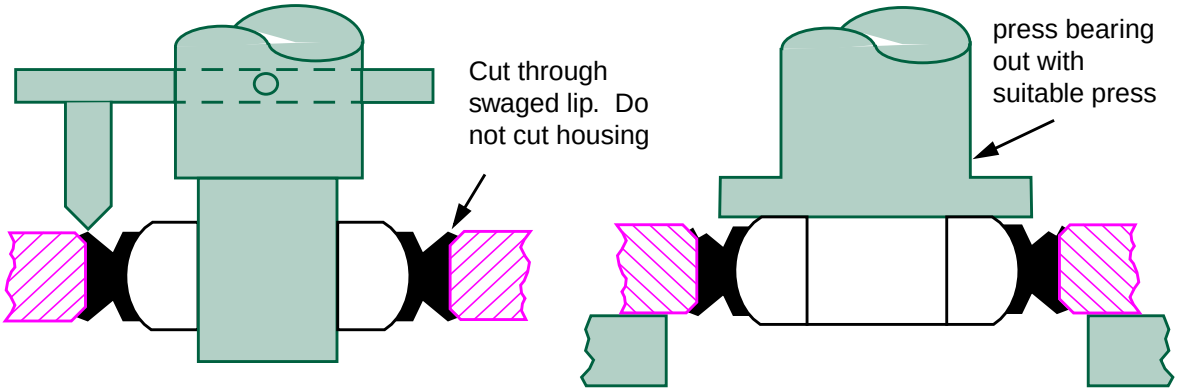


Figure 4 - Removal of Swaged Bearings

6 Requirements

6.1 Visual Examination

6.1.1 Examine all swaged bearings for evidence of cracks, looseness or rotation of the bearing race. The assembly is not acceptable if there is:

- Evidence of cracks in the bearing race
- Looseness or rotation of the bearing race in the housing.
- Evidence of binding of the bearing ball in movement through its full misalignment angle (check for binding before and after installation).

6.2 Dimensional Examination

6.2.1 Use a feeler gauge to measure the distance between the housing chamfer and the swaged lip on all swaged bearings (see Figure 5). The maximum acceptable edge gap is 0.006". Remember to check both sides of MS bearings.

6.2.2 Swaged bearing assemblies which have an edge gap larger than 0.006" may be re-swaged once. If the edge gap is still larger than 0.006" after two swagings, refer the assembly to the Materials Review Board (MRB) for disposition.

6.2.3 On both sides, the bearing race shall be no more than 0.005" below flush to no more than 0.010" above flush with the housing as shown in Figure 6.

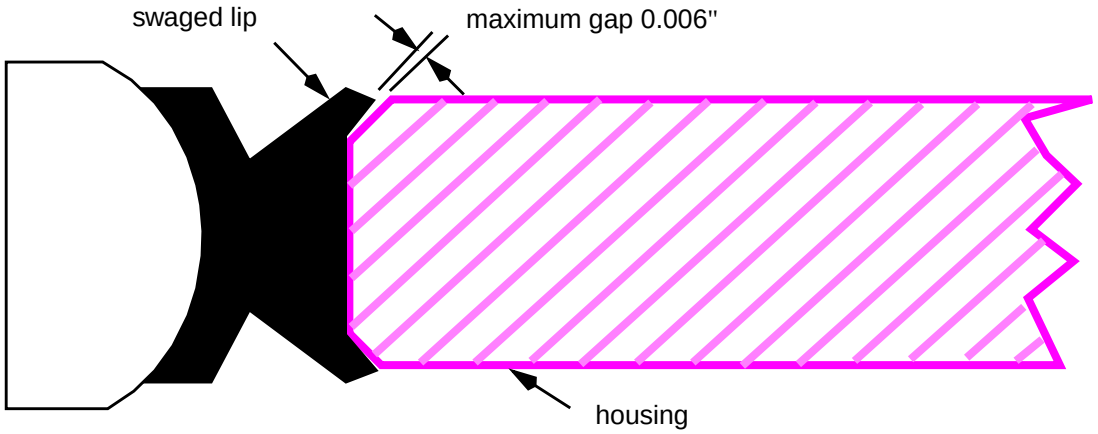


Figure 5 - Maximum Edge Gap

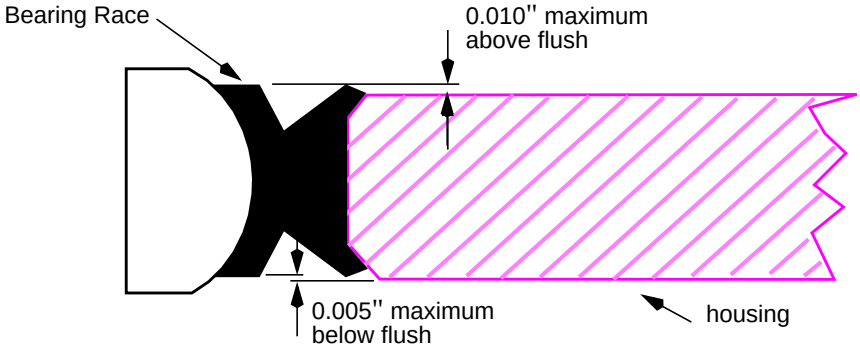


Figure 6 - Flushness Requirements

6.3 Proof Load

6.3.1 Select a sample from each production lot as specified in Table 7 and apply a proof load as shown in Figure 7 as follows:

Step 1. Select the appropriate proof loading tools for the bearing from Table 9 (MS bearings) or Table 10 (PSI bearings).

Step 2. Install the proof loading tools in a suitable hydraulic press (see Equipment section, paragraph 4.2.2).

Step 3. Support the part on the lower anvil by the edge of the housing bore.

Step 4. Unless otherwise specified on the engineering drawing, apply the axial proof load specified in Table 8 to the bearing race.

6.3.2 The assembly is not acceptable if the bearing race moves within the housing during proof loading. If any of the samples in a particular production lot is defective, check every bearing assembly in that production lot. Parts that do not meet the requirements are not acceptable.

6.3.3 If a bearing assembly meets the proof load requirements, use a Dalo marker to apply a small yellow dot to the part surface adjacent to the bearing.

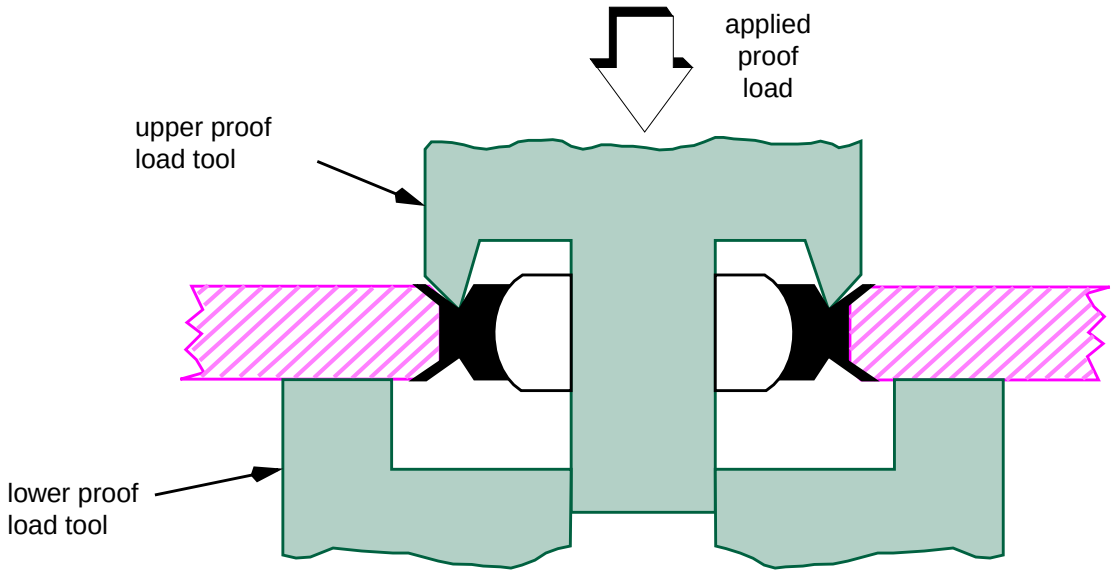


Figure 7 - Proof Loading

Table 7 - Sampling Schedule

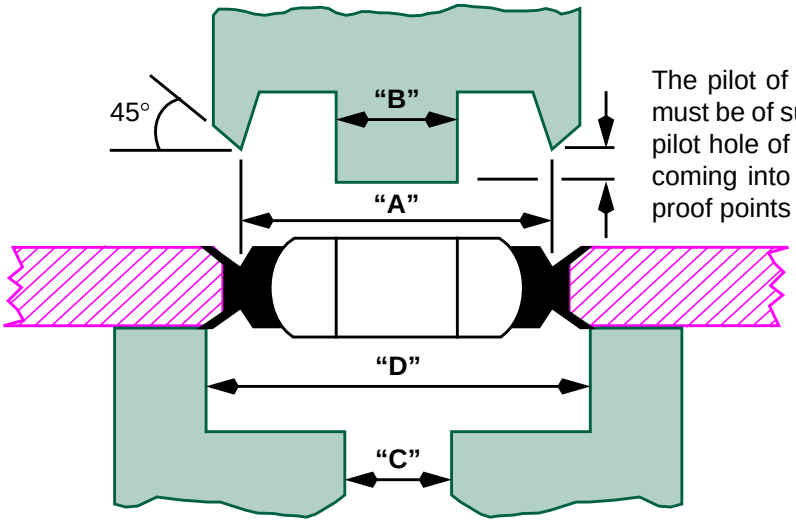
PRODUCTION LOT SIZE	1 - 5	6 - 25	26 - 50	51 - 90	91 - 150
SAMPLE SIZE (RANDOMLY SELECTED)	ALL	5	8	13	20
Note 1. If any of the samples selected do not meet the requirements of section 6, check every bearing assembly in that production lot.					

Table 8 - Proof Load Requirements

BEARING		PROOF LOAD
MS14101 & MS21232	-4	400 - 440 lbs
	-5 & -5A	700 - 770 lbs
	-7	1,400 - 1,540 lbs
	-8	2,100 - 2,310 lbs
	-9	2,460 - 2,706 lbs
	-14	6,220 - 6,842 lbs
P2A1560	2 OD. X 1 1/4 ID.	3,200 - 3,520 lbs

BEARING		PROOF LOAD
MS14103	-4	900 - 990 lbs
	-5	1,100 - 1,210 lbs
	-6	1,800 - 1,910 lbs
	-7	2,100 - 2,310 lbs
	-8	2,100 - 2,310 lbs
	-9	2,300 - 2,530 lbs
	-10	2,500 - 2,750 lbs
	-14	4,400 - 4,840 lbs

Table 9 - MS Bearing Proof Loading Tool

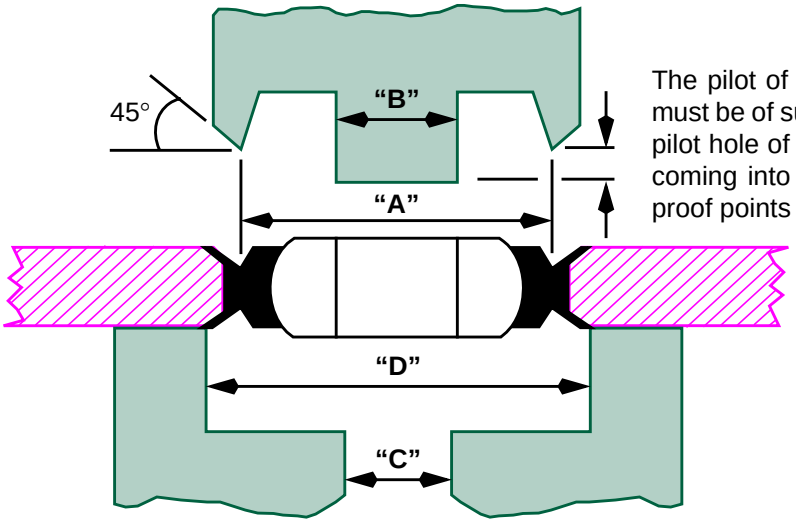


The pilot of the upper proof loading tool must be of sufficient length to engage the pilot hole of the lower tool by 1/4" before coming into contact with the swaging or proof points of the bearing race.

BEARING		PROOF LOADING TOOL DIMENSIONS			
		"A"	**"B"**	**"C"**	**"D"** (Note 1)
MS14101	-4	0.595" - 0.597"	0.248" - 0.249"	0.250" - 0.251"	0.756" - 0.766"
	-5	0.651" - 0.653"	0.310" - 0.311"	0.313 - 0.314	0.890" - 0.900"
	-5A	0.661" - 0.663"			
	-7	0.807" - 0.809"	0.435" - 0.436"	0.438" - 0.439"	1.046" - 1.056"
	-8	0.877" - 0.879"	0.498" - 0.499"	0.500" - 0.501"	1.220" - 1.230"
	-9	0.971" - 0.973"	0.560" - 0.561"	0.563" - 0.564"	1.314" - 1.324"
	-14	1.439" - 1.441"	0.873" - 0.874"	0.875" - 0.876"	1.783" - 1.793"

Note 1. Dimension "D" may be decreased provided that the proof loading tool does not come into contact with the outer race of the bearing.

Table 9 - MS Bearing Proof Loading Tool

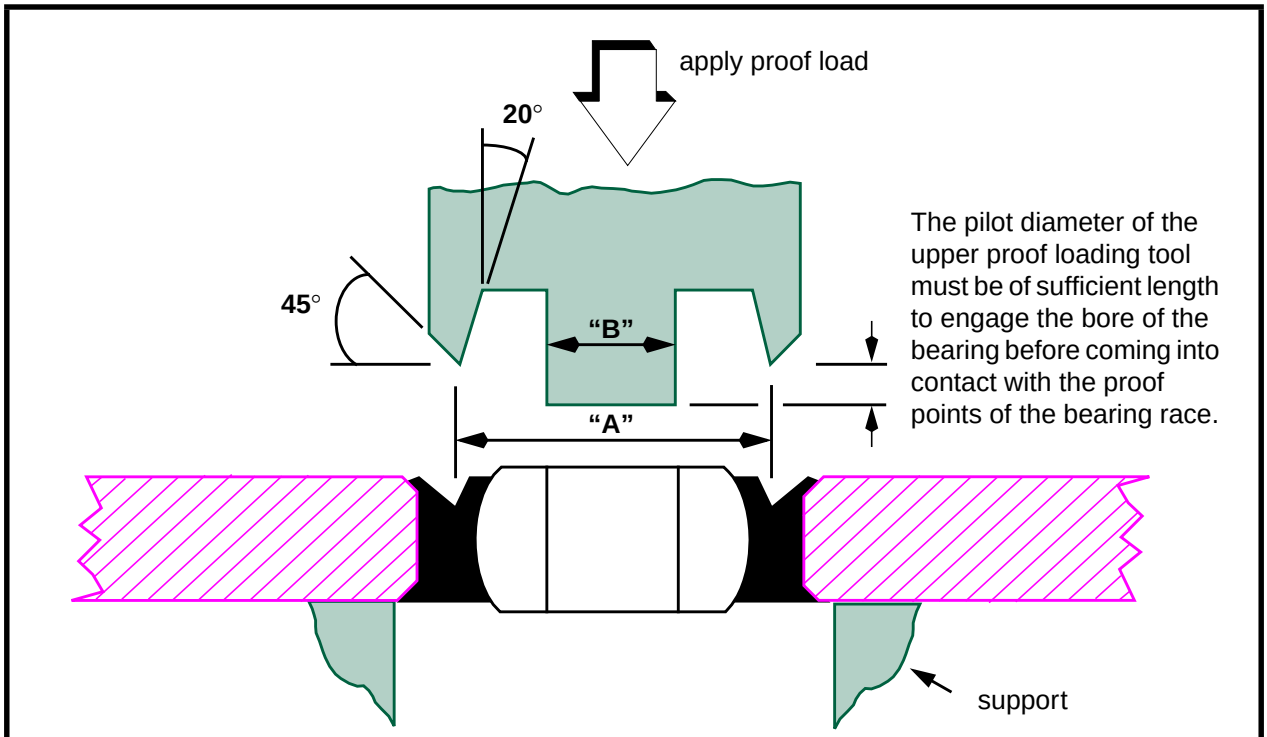


The pilot of the upper proof loading tool must be of sufficient length to engage the pilot hole of the lower tool by 1/4" before coming into contact with the swaging or proof points of the bearing race.

BEARING		PROOF LOADING TOOL DIMENSIONS			
		"A"	**"B"**	**"C"**	**"D"** (Note 1)
MS14103	-4	0.564" - 0.566"	0.248" - 0.249"	0.250" - 0.251"	0.725" - 0.735"
	-5	0.626" - 0.628"	0.310" - 0.311"	0.313" - 0.314"	0.788" - 0.798"
	-6	0.713" - 0.715"	0.373" - 0.374"	0.375" - 0.376"	0.952" - 0.962"
	-7	0.838" - 0.840"	0.435" - 0.436"	0.438" - 0.439"	1.078" - 1.088"
	-7A	0.807" - 0.809"			1.046" - 1.056"
	-8	0.901" - 0.903"	0.498" - 0.499"	0.500" - 0.501"	1.140" - 1.150"
	-9	1.026" - 1.028"	0.560" - 0.561"	0.563" - 0.564"	1.265" - 1.275"
	-10	1.088" - 1.090"	0.623" - 0.624"	0.625" - 0.626"	1.338" - 1.348"
	-14	1.502" - 1.504"	0.873" - 0.874"	0.875" - 0.876"	1.845" - 1.855"
MS21232	-4	0.572" - 0.574"	0.248" - 0.249"	0.250" - 0.251"	0.766" - 0.776"
	-5	0.636" - 0.638"	0.310" - 0.311"	0.313" - 0.314"	0.900" - 0.910"
	-7	0.792" - 0.794"	0.435" - 0.436"	0.438" - 0.439"	1.056" - 1.066"
	-8	0.861" - 0.863"	0.498" - 0.499"	0.500" - 0.501"	1.230" - 1.240"
	-9	0.955" - 0.957"	0.560" - 0.561"	0.563" - 0.564"	1.324" - 1.334"
	-14	1.424" - 1.426"	0.873" - 0.874"	0.875" - 0.876"	1.793" - 1.803"

Note 1. Dimension "D" may be decreased provided that the proof loading tool does not come into contact with the outer race of the bearing.

Table 10 - PSI Bearing Proof Loading Tool



BEARING	PROOF LOADING TOOL DIMENSIONS	
	"A"	"B"
P2A1560	1.874" - 1.880"	1.246" - 1.248"

7 Safety Precautions

7.1 The safety precautions specified herein are specific to Bombardier Toronto to meet Canadian Federal and Provincial government environmental, health and safety regulations. It is recommended that other facilities consider these safety precautions; however, suppliers, subcontractors and partners are responsible for ensuring that their own environmental, health and safety precautions satisfy the appropriate local government regulations.

7.2 Observe general shop safety precautions when performing the procedure specified herein.

8 Personnel Requirements

8.1 Personnel responsible for the installation of self-aligning bearings by roller or press swaging must have a good working knowledge of the procedure and requirements as specified herein and shall have exhibited their competency to their supervisor.